# DATA PROCESSING THROUGH BIOSENSORS AND DEVELOPMENT OF SIMULATION SOFTWARE IN RTLINUX

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**Spring 2011**

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# C O N T E N T S

# Abstract

Biomedical engineering is the application of engineering principles and techniques to the medical field. The development of biomedical engineering is responsible for improving healthcare diagnosis, monitoring and therapy. Biosensors are analytical devices those are used to detect the sensitive biological elements such as tissue, microorganisms, organelles, cell receptors, enzymes, antibodies, nucleic acids, etc.

We will develop a biomedical device that will responsible for getting data through 16 channels. The channels are connected with the biosensors through which we will get the signal of different biological state (e.g. ECG, BP etc) of a human or animal. Obtaining signal from the Biosensors Data acquisition process will be done which is a signal processing system that can measure real world physical conditions and converting the resulting samples into digital numeric values that can be manipulated by a computer. Since after the processing of data it is important to show it in a user friendly way, a Graphical User Interface (GUI) will be developed in Linux environment.

# Objective

The aim of the project is to develop a standard biomedical device that will provide data acquisition system for collection, management, control and analysis of biomedical experiments. To obtain the objective four things will be needed to done properly which are given below:

1. Processing signal coming from different kind of biosensors.
2. Data acquisition of the sampled signal to convert it into digital numeric value and pass it to the computer.
3. Linking Linux to RT Linux for showing Real Time data in graphical interface.
4. Development of a graphical user interface in Linux to show the outputs.

The software that will be developed in Linux environment will be linked to RT Linux for obtaining real time data and will have its own graphical user interface which will analyze all the data coming from the data acquisition card and show it in a user friendly way . Integration of the software and data acquisition system will provide an ideal package for biomedical experimentation.

# Background and Motivation

Medical physics is an area of increasing importance in hospitals and in health-related occupations. Physics is used in medicine to diagnose illness and disorder and to design appropriate treatment and solutions. Biomedical engineering is a field of research of high importance in any sense around the world. Biomedical engineering is also a very sensitive field of engineering measurement where delay of a second can cause someone life's to death. So Real time computing has great importance in the field of biomedical engineering. There are always sensitive cases where it needs to follow up the pulse rate, blood pressure etc for every single moment. If one data is missed or cannot be processed in due time by the machine (biomedical instrument) it may cause serious impact on the patient's body. So real time patient monitoring or medicine testing equipment has great importance in healthcare. As we know Bangladesh is very good in pharmaceuticals research and development. But due to lack of medicine testing equipment they cannot prosper as expected. Cost effective patient monitoring system has also great importance for giving proper treatment to every people of the country. A real time patient monitoring and medicine testing equipment will fulfill all the needs.

# Project Overview

The goal of the project is to develop a 16 channel data acquisition system which will receive the analog biomedical signals from human body/animal and send these signals to computer. The signal processor will filter, amplify, and cancel the noise of the analog signal (ASP) coming from the transducers of the biosensors and will send it to data acquisition system (DAQ) for digital signal processing. DAQ will digitize the signal and convert it into digital numeric value so that it can be manipulated by the computer. The computation will be done in real time Linux (RT Linux). There will be a graphical user interface (GUI) developed in Linux environment to show the outputs those actually come from biosensors. The GUI will take signal from RT Linux and show it in real time.

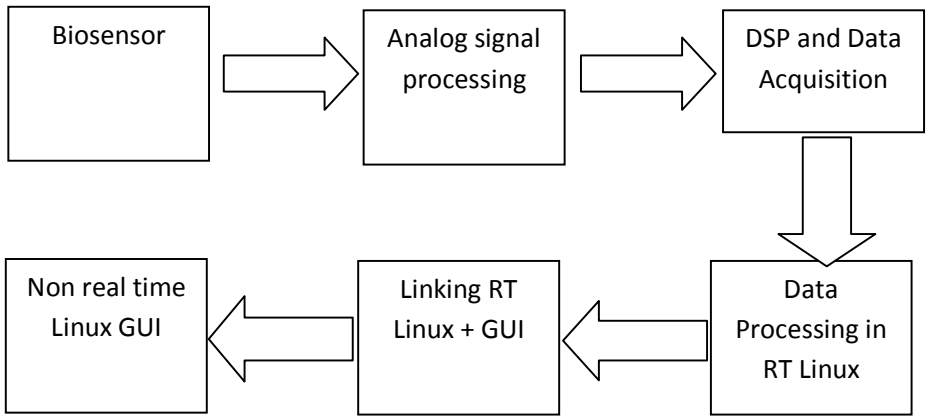



**Figure: The flow of the project's I/O system.**

Some of the channels (Among 16 channels) those will be used for measuring different signals which are given below.

Channel 1: ECG signal measurement

Channel 2: Cardiac Output (CO) measurement (flow meter signal)

Channel 3: Coronary Blood Flow (CBF) measurement

Channel 4: Aortic Pressure (AP) measurement

Channel 5: EMG signal measurement

Channel 6: Blood Pressure measurement

Channel 7: Oxygen saturation measurement

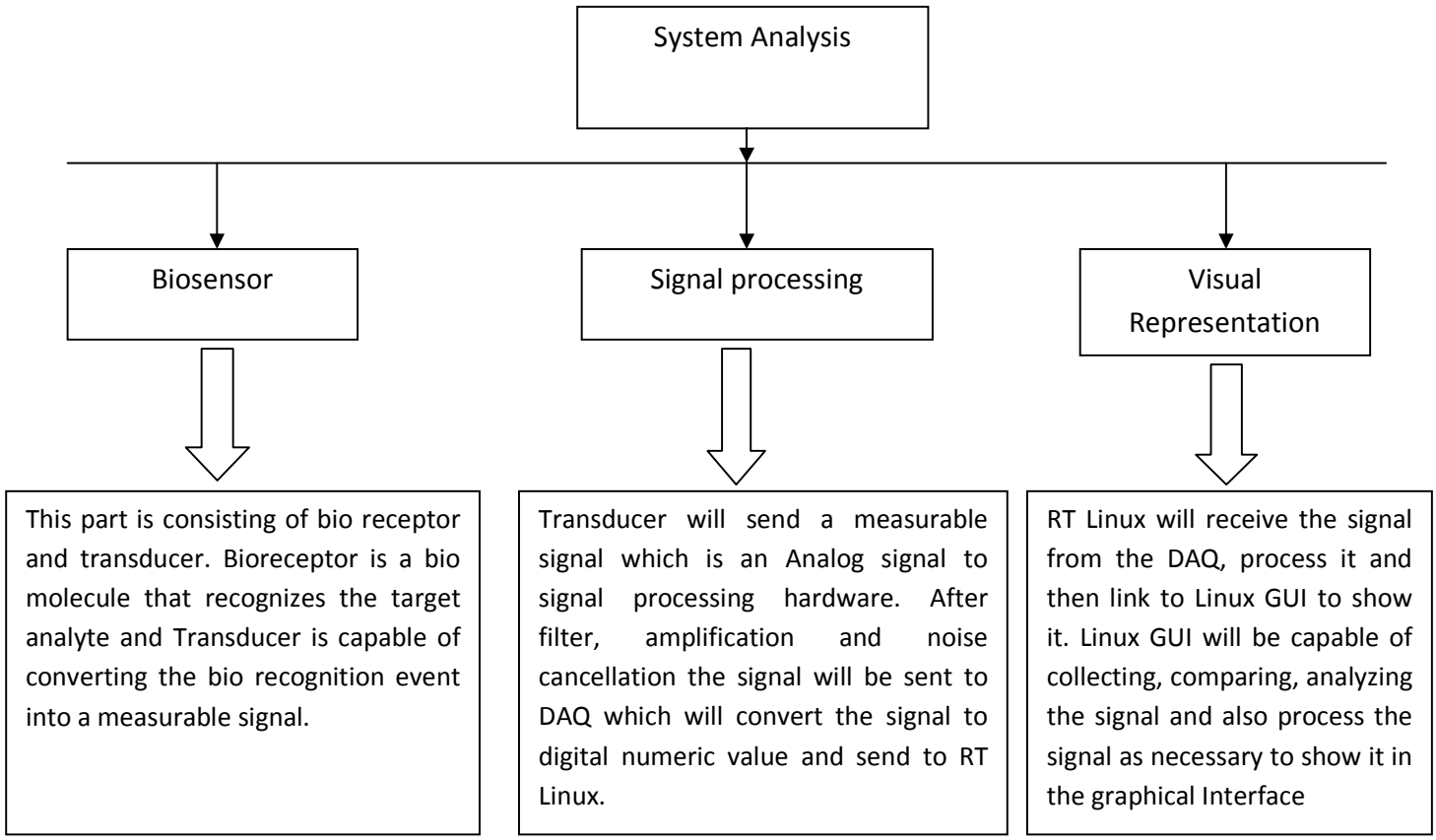
Channel 8: Heart Rate

Channel 9: Respiratory rate

Channel 10: Body Temperature

## System Analysis

The analysis of the proposed system is necessary to gain the prime objective properly. By analyzing the system we get three major parts. The major parts of the systems and also the components of the parts have been briefly described below in the diagram.

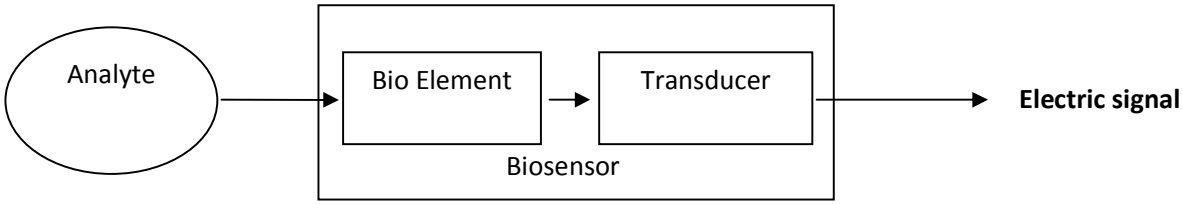


# Biosensors

**Elements of Biosensor:** A biosensor is consisting of two element bio-element and sensor-element. Bioreceptor is the bio-element and transducer is the sensor-element.

1. Bioreceptor: The bioreceptor is a bimolecular that recognizes the target analyte. It can be enzyme, antibody, tissue, etc.

2. Transducer: The transducer should be capable of converting the bio recognition event into a measurable signal. Typically, this is done by measuring the change that occurs in the bioreceptor reaction. The signal can be electric potential, electric current, mass, temperature, viscosity etc.




**Types of Sensor-Subject Interfaces:**

- No contacting (noninvasive)
- Skin surface (contacting)
- Indwelling (minimally invasive)
- Implantable (invasive)

**Signal and different types of sensors:**

| ***Signals*** | ***Sensors*** |
|---|---|
| ECG signal | ECG Electrodes |
| Cardiac Output (CO) measurement (flow meter signal) | CBF sensor |
| Coronary Blood Flow (CBF) measurement | |
| Aortic Pressure (AP) measurement | |

| | |
|---|---|
| EMG signal measurement | SX230 Electrode |
| Blood Pressure measurement | |
| Respiratory Rate | Rainbow Acoustic Sensor |
| Blood Pressure measurement | Sphygmomanometer |
| Oxygen Saturation | Pulseoximeter |
| Heart Rate | Pulseoximeter |
| Body temperature | LM35 |

# Signal Processing

Signal processing is one of the major parts of the project. Signal will be processed in two phase. First phase is analog signal processing coming from the transducer of the biosensors. Second phase is digital signal processing and data acquisition system. Data acquisition system will send digital numeric value to the RT Linux.

**Analog signal processing:** The analog signal processing (ASP) will be done immediately after the signal comes from transducer of the biosensor. The transducer gives a signal that is electric in form. The signal will be filtered first. After the filter process amplification will be done to increase the intensity of the signal. Then it is needed to cancel the noise of the signal to get a proper signal. This whole process is the ASP for the project.

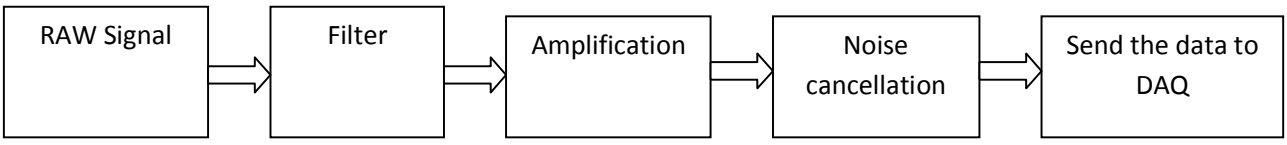



**Figure: Analog Signal Processing**

**Data Acquisition:** Data acquisition is the process of sampling signals that measure real world physical conditions and converting the resulting samples into digital numeric values that can be manipulated by a computer. Data acquisition systems typically convert analog waveforms into digital values for processing.

The components of data acquisition systems include:

- Sensors that convert physical parameters to electrical signals.
- Signal conditioning circuitry to convert sensor signals into a form that can be converted to digital values.
- Analog-to-digital converters, which convert conditioned sensor signals to digital values.

DAQ hardware is what usually interfaces between the signal and a PC. It could be in the form of modules that can be connected to the computer's ports (parallel, serial, USB). DAQ cards contain multiple components (multiplexer, ADC, DAC, TTL-IO, high speed timers, RAM).

We will use the DAQ card which has 16 channels. The DAQ will convert the analog signal to digital and make it appropriate so that can be manipulated by the computer. After digitization, DAQ will send the data to Real Time Linux. The 16 channels of the DAQ will bring the signal from 16 biosensors.

iWorx Data Acquisition System (HAI 118)

# Visual representation

Visual representation is necessary to make the data accessible to the doctor and researcher. Visual representation of data depends on three things. Initially the data will be received by RT Linux. Since the data will be shown in a real time presentation it is needed to make a link to real time data and graphical interface in Linux.

**RT Linux:** Real time Linux will take the data passed from data acquisition card. After processing the data in real time , RT-Linux will be linked to Non real time GUI in Linux to show the output in user friendly way . RT Linux has now been used extensively in research purpose of developing real time system.

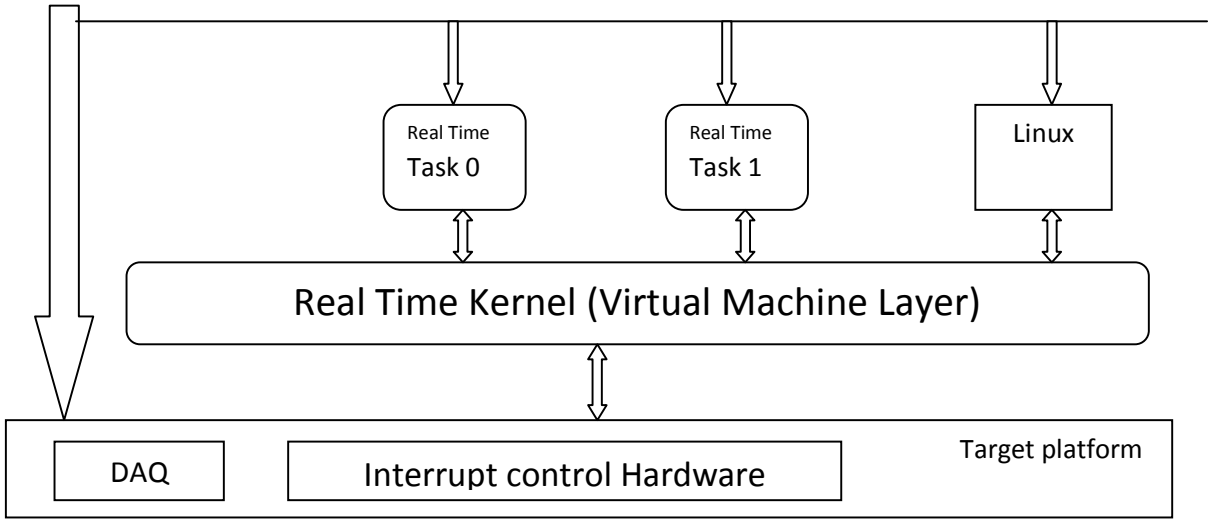



**Figure: Real time tasking in RT Linux.**

**Reason behind RT Linux:** There is a significant need for an open source hard real-time experiment interface system that is free from the some limitations. It provides a flexible, modular, and powerful general-purpose hard real-time experiment interface system that is freely available to the scientific community. Let's think of an ECG simulator, a machine is continuously taking samples (heart bit rate) from human heart which is brought through a 16 channel data acquisition card and passed it to computer. Now The computer must receive the input from the data acquisition board, process the signal to determine the input amplitude and send it to the simulator to obtain the graphical representation of the patients heart condition which we call electro cardiogram (ECG).This total analysis should be done let in 1ms.If somehow the computer miss any of the samples or fail to analyze the signal within the predefined time limit the consequence can be unpredictable. This is why the real Time analysis comes in necessity. RT Linux can give nanosecond precision which is very much suitable for biomedical experimentation. So as a sensitive biomedical issue RT Linux is very much appropriate for the system. Another good reason for using RT Linux is it is open source.

**Linux GUI:** The graphical user interface will be developed in Linux to show the output. Linking Linux GUI to RT Linux is very much necessary for the process. Linking will be done in GNU C programming language. Graphical interface will be developed in QT creator and KDevelop. QT creator and KDevelop is open source graphical interface development environment in Linux. The GUI will collect, show and manage the data coming from RT Linux. The GUI will have option for saving data so that it can be used in future for research work.

# Timeline

| Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 | Week 7 | Week 8 | Week 9 | Week 10 | Week 11 | Week 12 | Week 13 | Week 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Feasibility Study | | Join in Conference | Prepare Work Outline | | | Study on DAQ And Bio-Sensors | | | Writing Report and Preparing Presentation | | | | Pre Thesis Presentation |

| Week 15 | Week 16 | Week 17 | Week 18 | Week 19 | Week 20 | Week 21 | Week 22 | Week 23 | Week 24 | Week 25 | Week 26 | Week 27 | Week 28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GUI Design in Linux + Find DAQ Card | | | Find and Buy Bio-Sensors | | Interface Bio-Sensor and DAQ Card | | Expert Visit | | Write Driver Software for DAQ card in Linux and Basic Interface of total System | | | Prepare Presentation | Thesis Presentation 1 |

| Week 29 | Week 30 | Week 31 | Week 32 | Week 33 | Week 34 | Week 35 | Week 36 | Week 37 | Week 38 | Week 39 | Week 40 | Week 41 | Week 42 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Final Implementation Part | | | Debug and Improve Software and Hardware | | Test and Add Missing Features | | | Document and Decorate the Final Product | | Prepare Final Report And Presentation | | | Final Thesis Presentation |

# References


1. Biosensor a Tutorial Review by Saraju.P.Mohantay and Elias kugojianas.
2. Biomedical sensor by Michal R. Neuman
3. http://en.wikipedia.org/wiki/RTLinux
4. http://en.wikipedia.org/wiki/Real_time_computing
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